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[54] **PIEZOELECTRIC LIGHTER WHICH HAS A HIGHER LEVEL OF DIFFICULTY FOR OPERATION**

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[21] Appl. No.: **768,545**

[22] Filed: **Dec. 18, 1996**

[51] **Int. Cl.**[6] **H01L 41/08**

[52] **U.S. Cl.** **310/339**; 310/328; 310/319; 361/260; 431/255

[58] **Field of Search** ..... 361/247, 260; 310/339, 340, 338; 313/234, 571, 572; 315/248, 209 PZ; 431/256, 131, 132, 255

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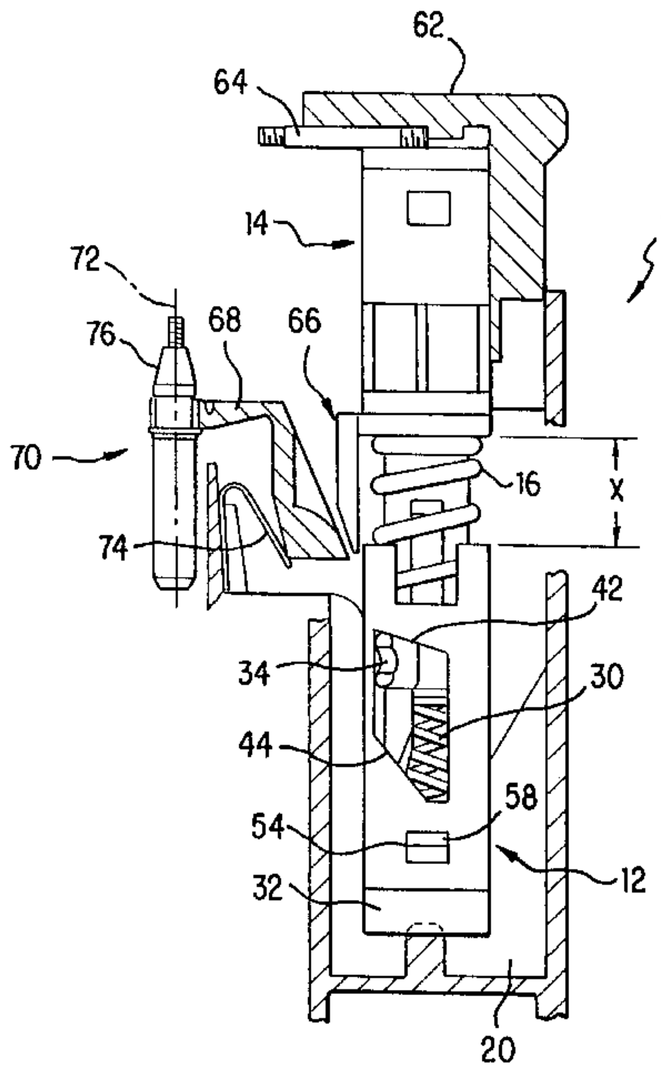
Primary Examiner—Mark O. Budd
Assistant Examiner—Timothy A. Williams
Attorney, Agent, or Firm—Pennie & Edmonds LLP

[57] **ABSTRACT**

The piezoelectric ignition mechanism of the present invention has a telescopic assembly having an inner and an outer members aided by a return spring for maintaining a maximum extension between the members. The inner member includes a piezoelectric element which is immobilized between an anvil and impact pad over which a plexor strikes to generate a spark. An impact spring for aiding the plexor is guided in the interior of the telescopic assembly and is disposed between the plexor and an end member connected to the outer telescopic member. A resistant spring is also disposed at or near the end member to provide additional resistance to the operation of the piezoelectric mechanism in order to discourage the undesirable operation by young users.

21 Claims, 6 Drawing Sheets



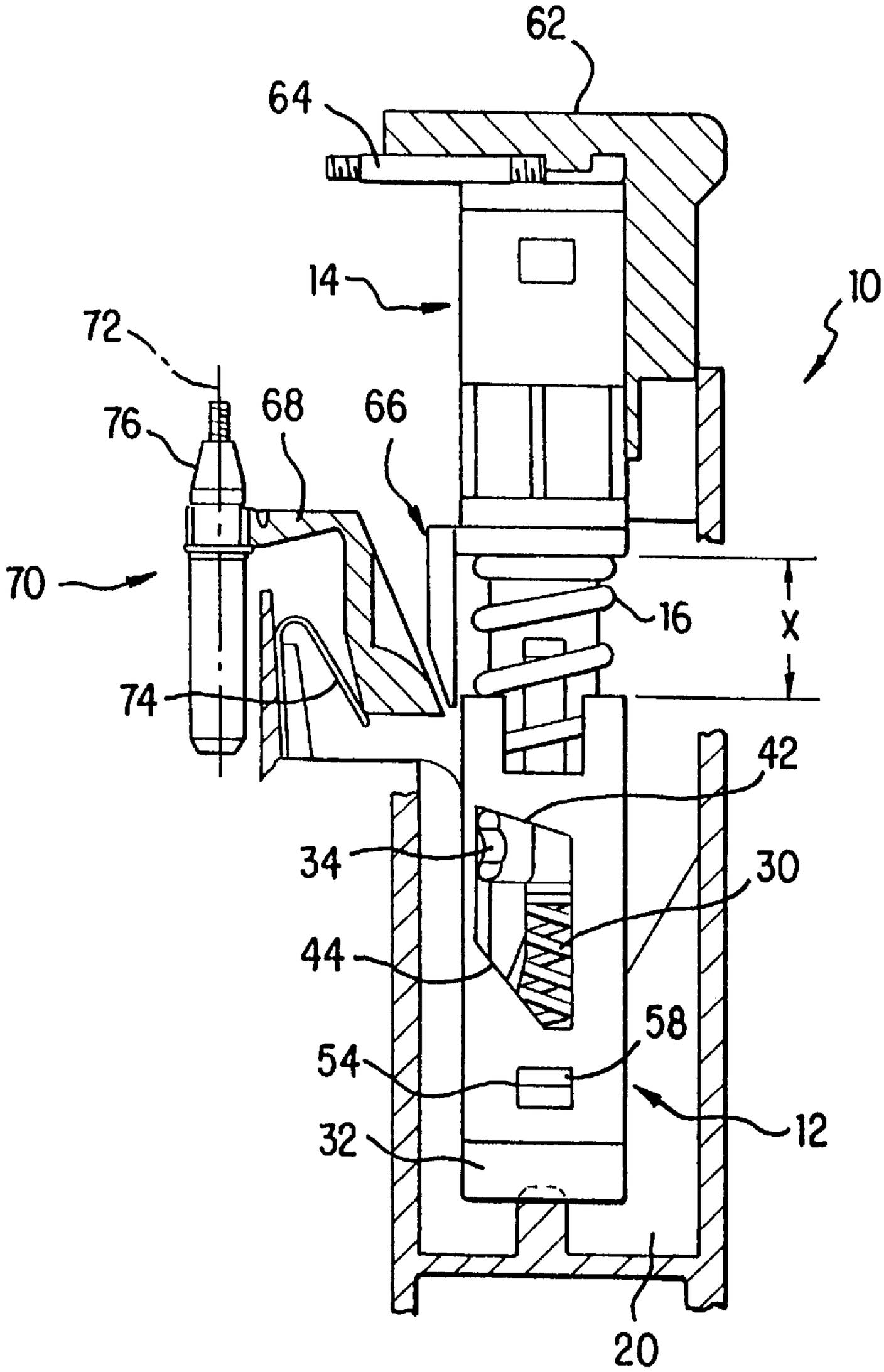


FIG. 1

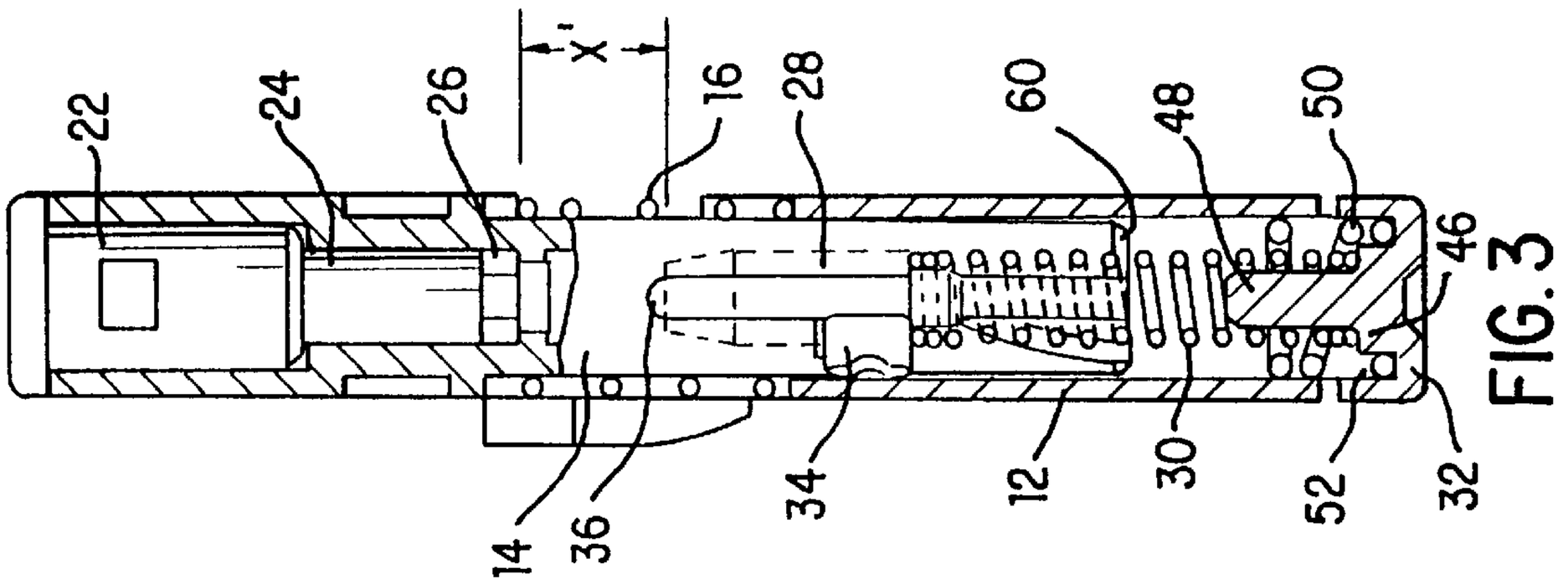

22
24
26
X'
16
28
60
48
50
46
14
36
34
12
30
52
32

FIG. 3

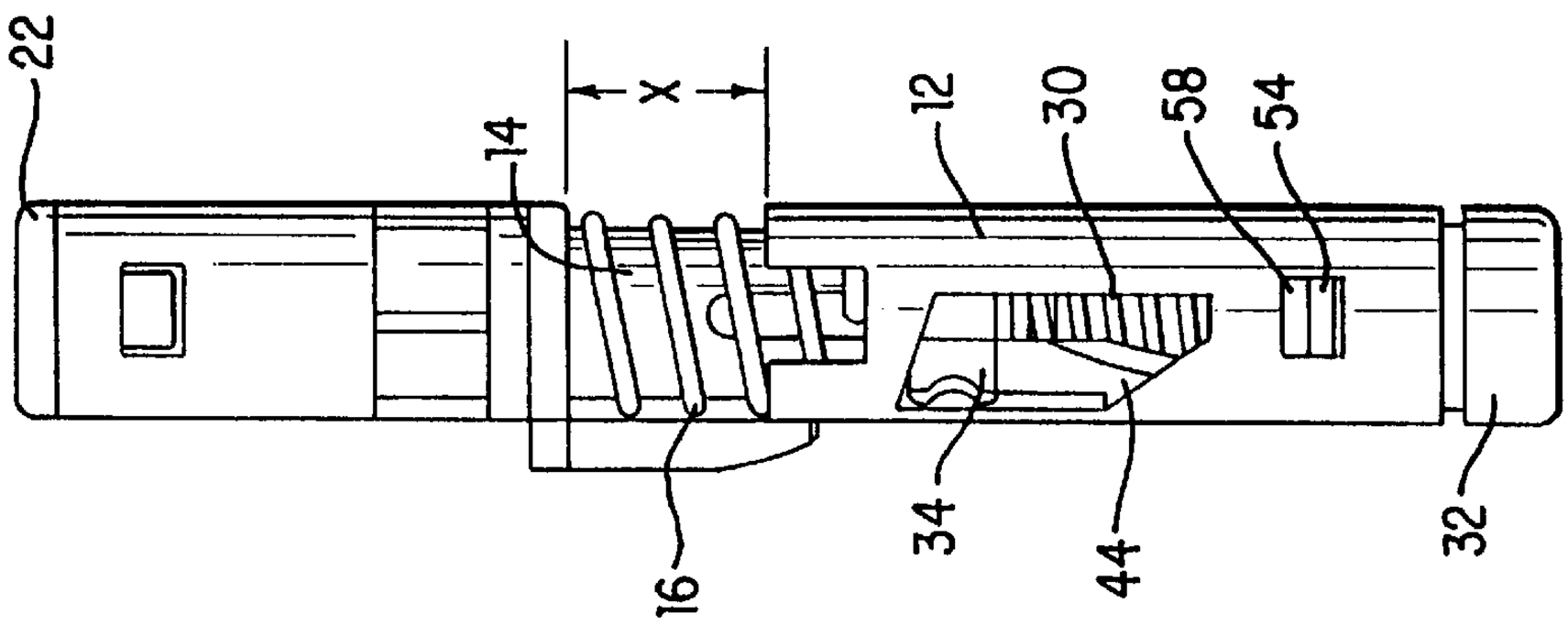

22
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FIG. 2

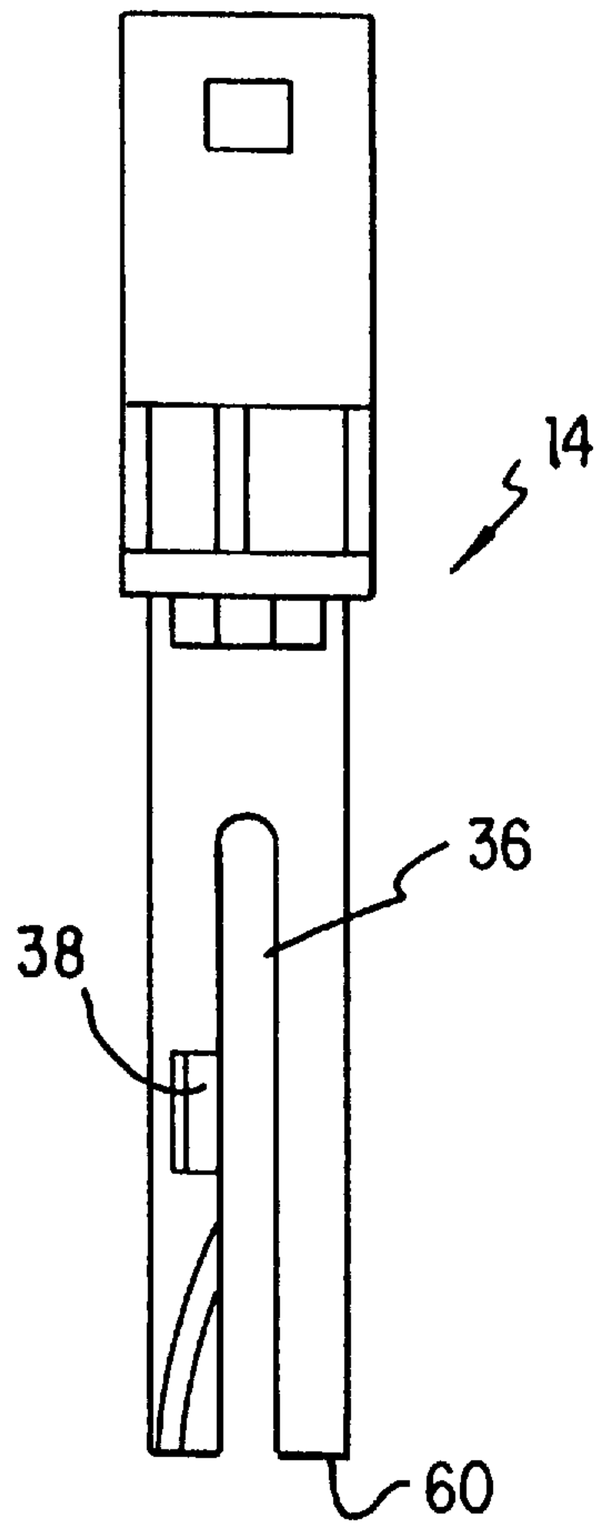

FIG. 4

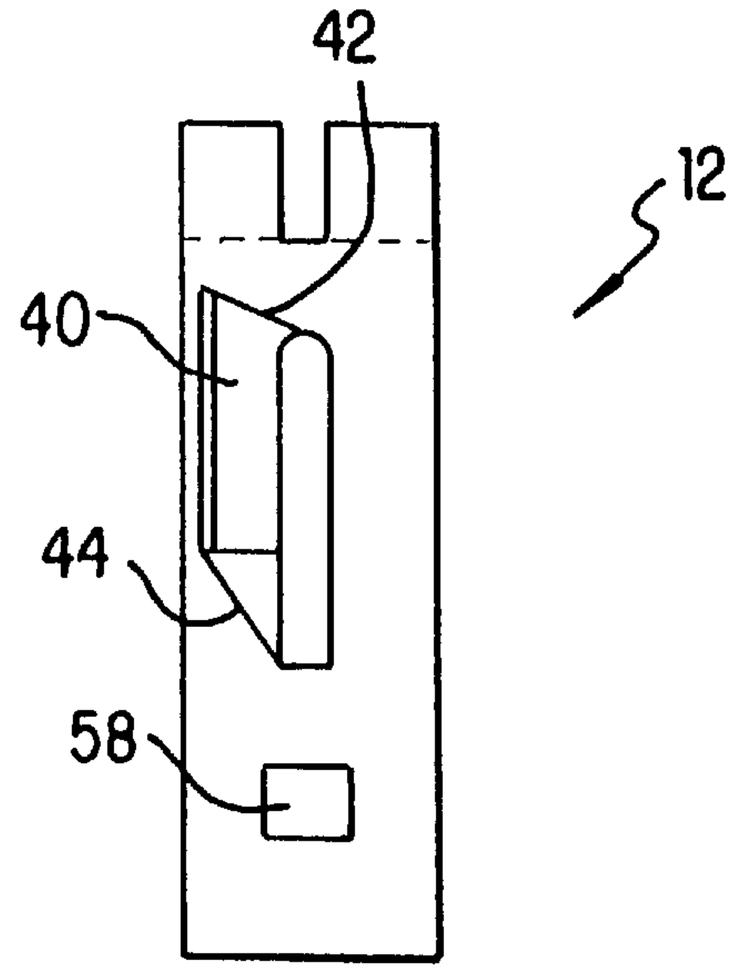

FIG. 5

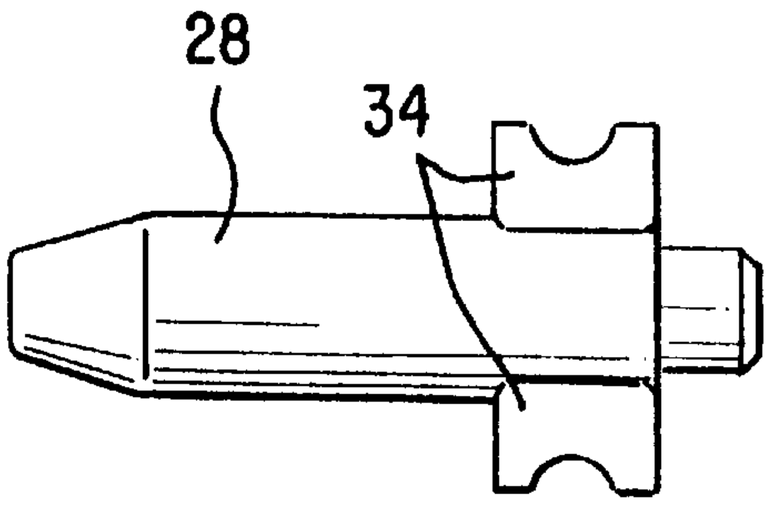

FIG. 6

FIG. 7

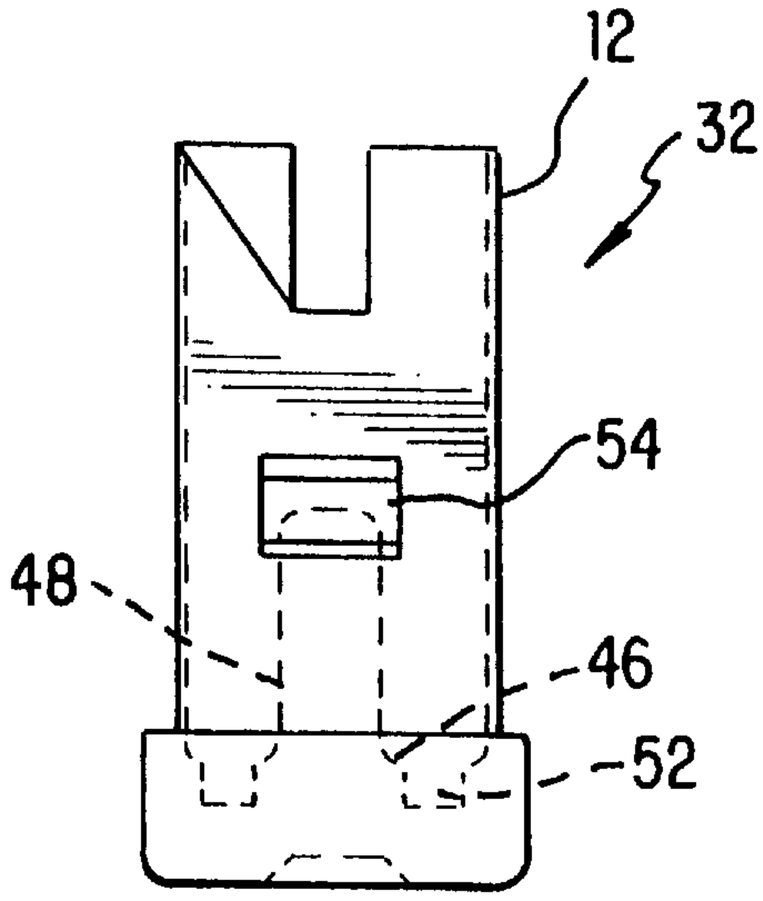

FIG. 8

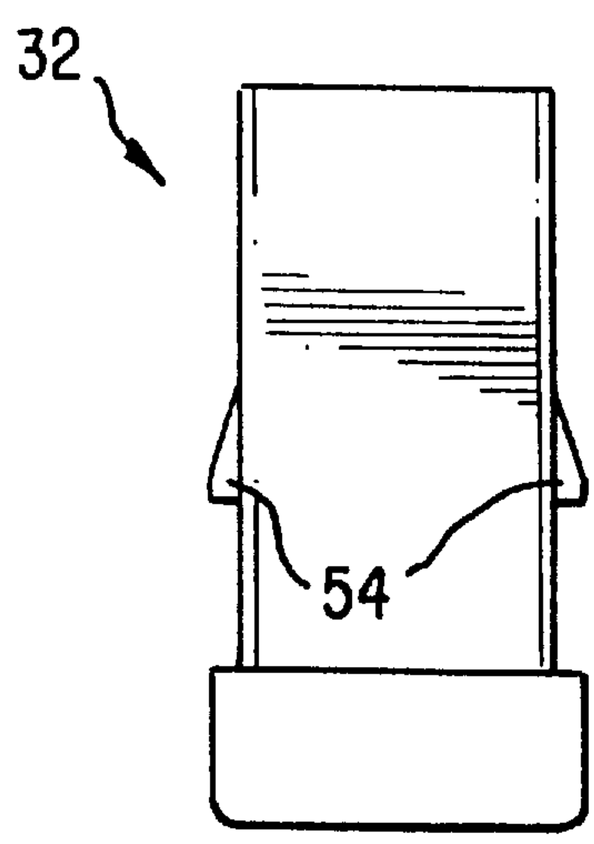

FIG. 9

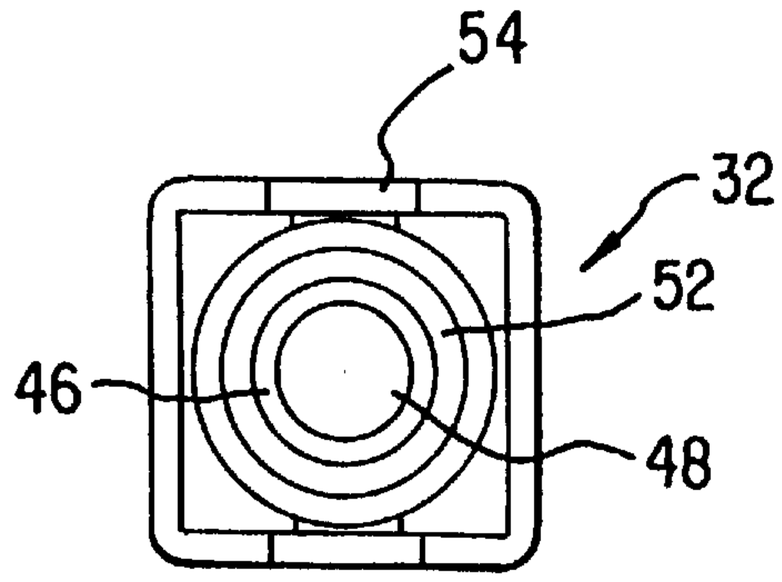

FIG. 10

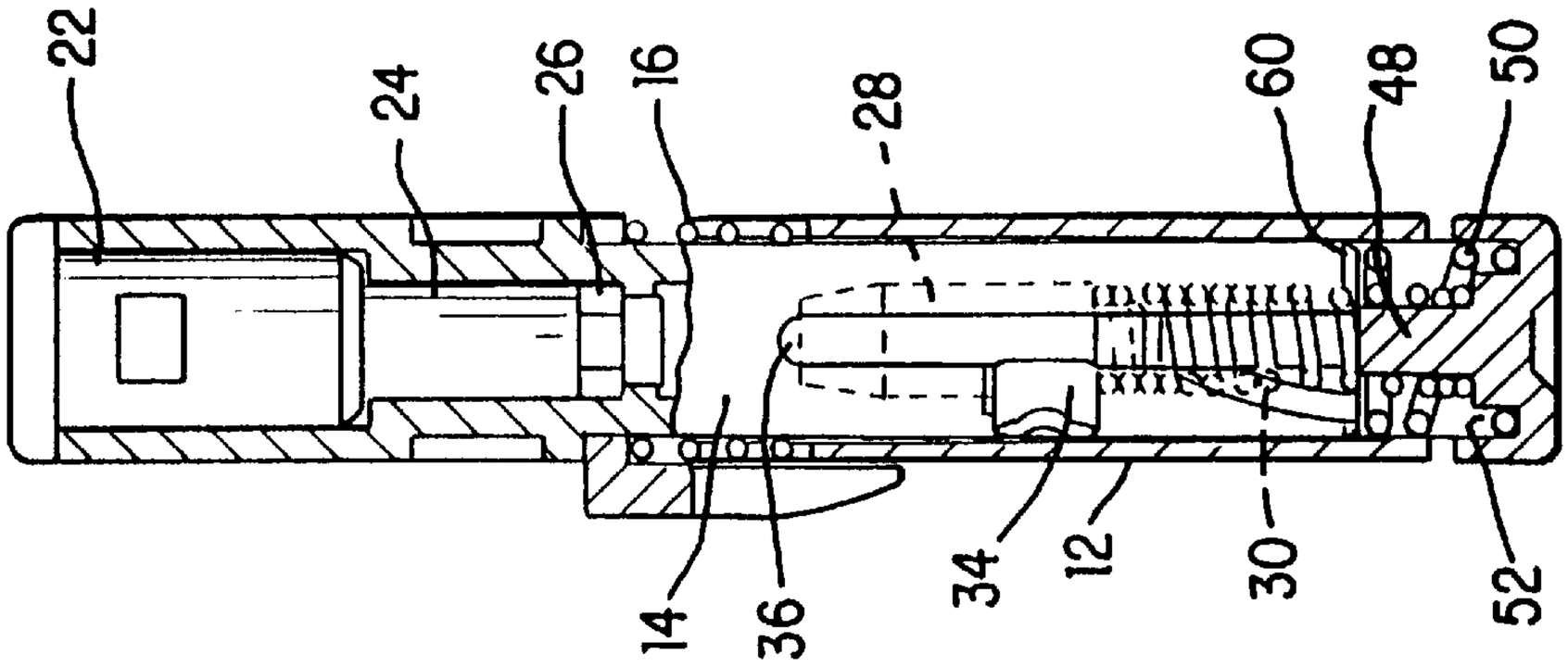

FIG. 12

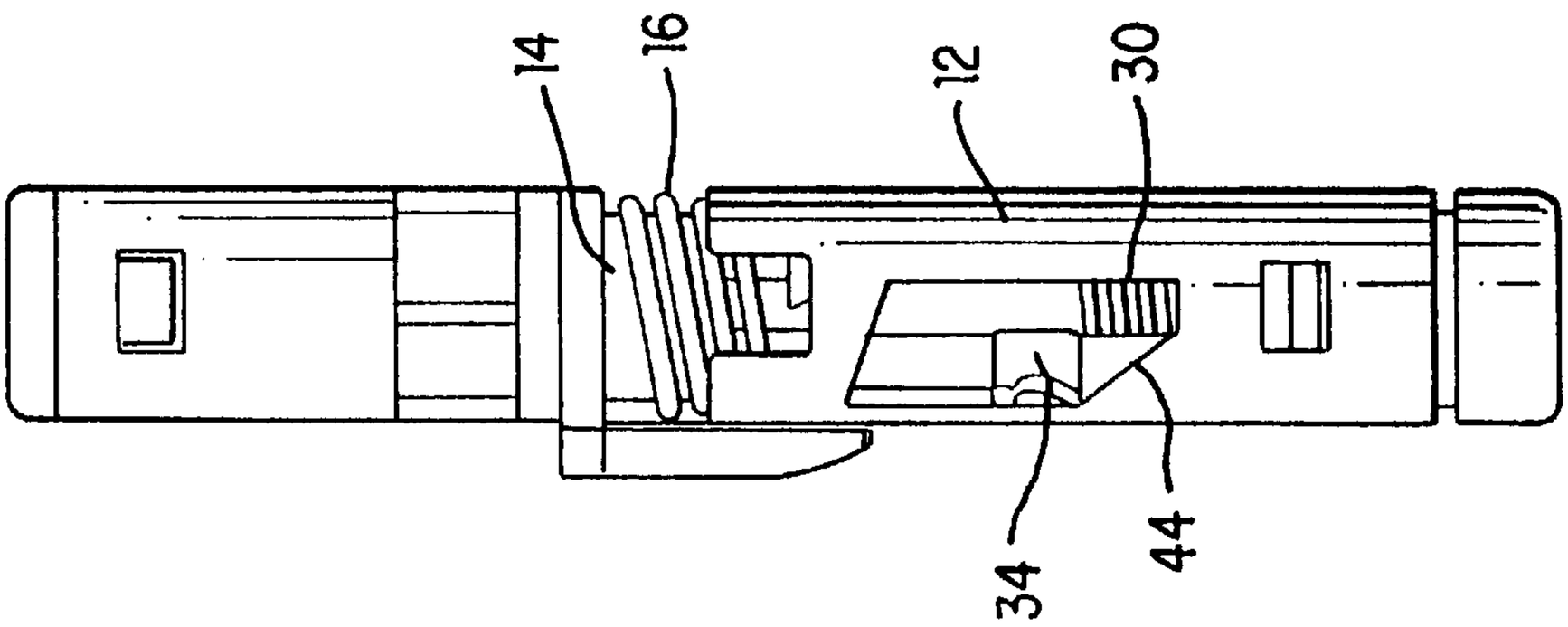

FIG. 11

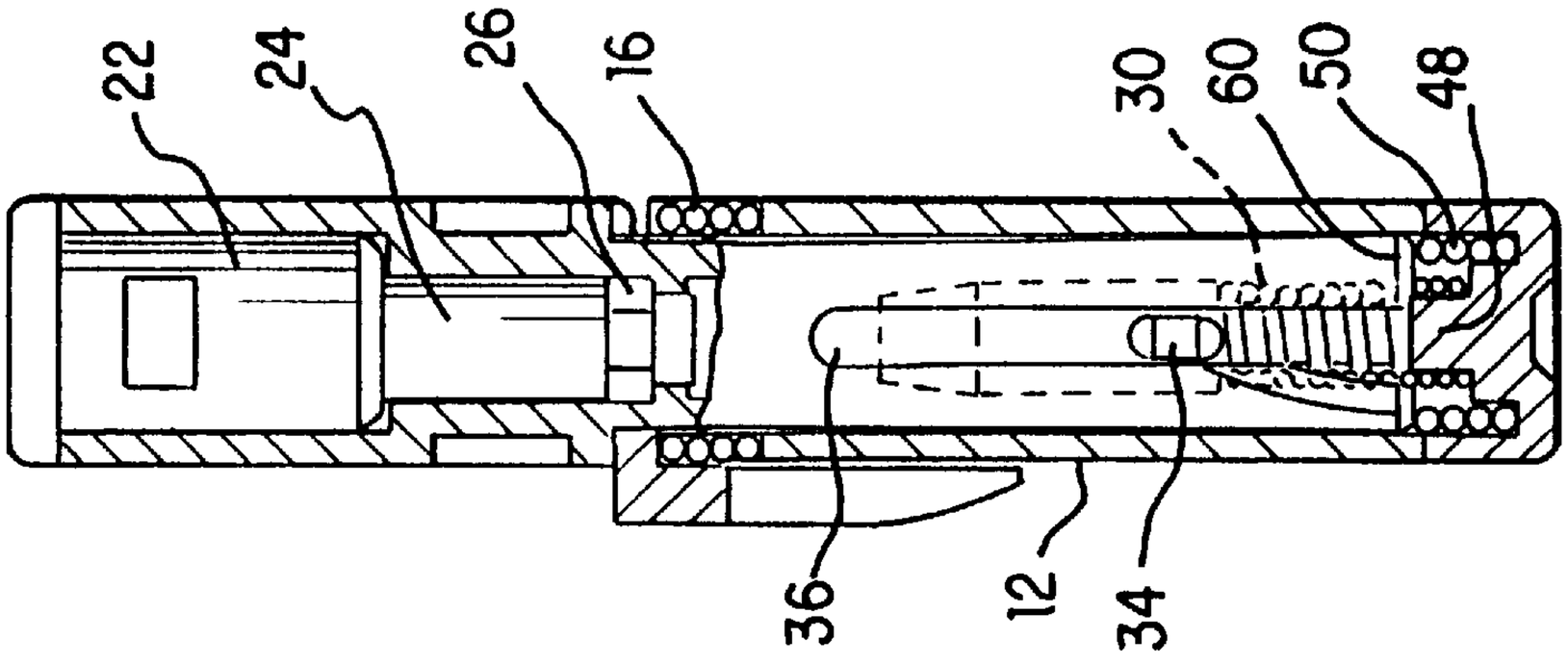

FIG.14

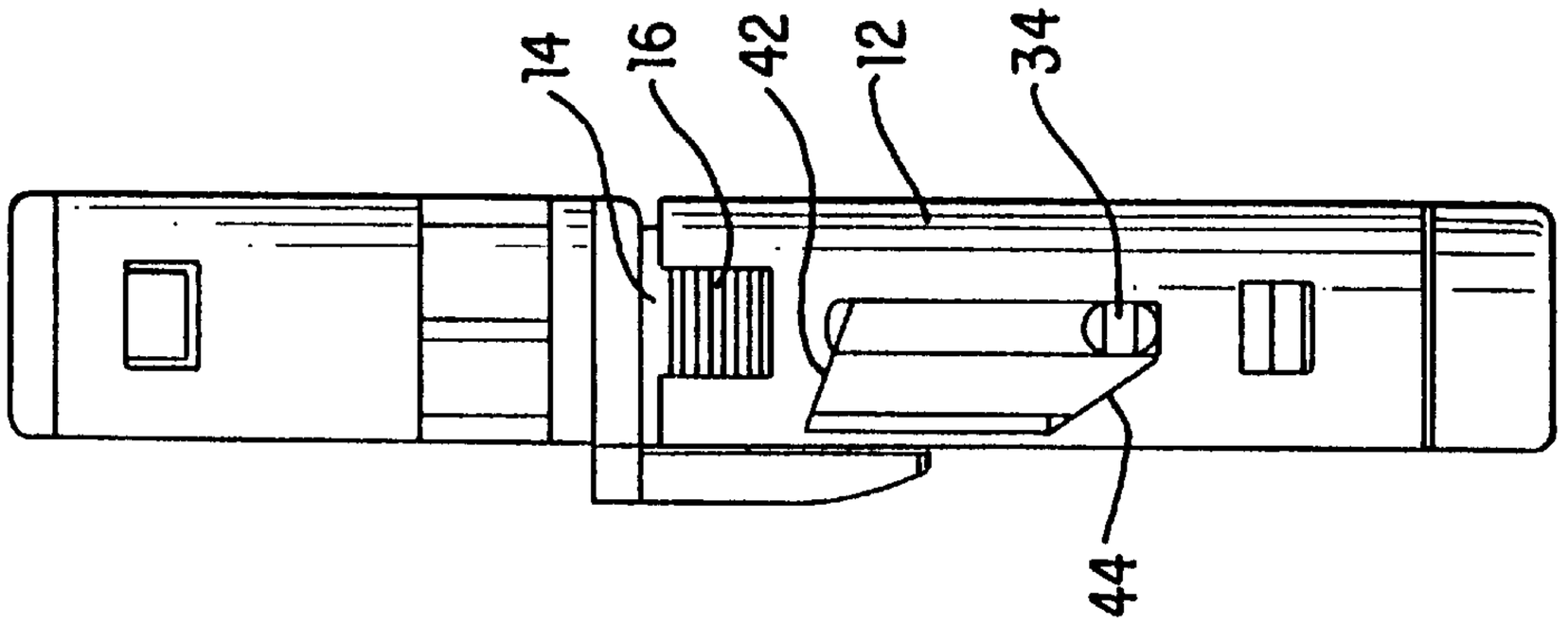

FIG.13

PIEZOELECTRIC LIGHTER WHICH HAS A HIGHER LEVEL OF DIFFICULTY FOR OPERATION

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates to a piezoelectric ignition mechanism, which includes a mechanism for resisting ignition by young users.

2. Background Art

A typical piezoelectric ignition mechanism is formed by a telescopic assembly having an inner member and an outer member that are separated by a return spring which maintains them in a position of maximum extension. Fixed to one of these members is a crystal or piezoelectric element, which provides a lighting spark when impacted by a plexor. The piezoelectric element, in turn, is placed between a metallic head, called an "anvil", and another member which actually receives the impact of the plexor, called an "impact pad".

The plexor is slideably received in the axial void inside of the telescopic body, and in a rest position is kept distant from the piezoelectric element due to the presence of a retaining mechanism. The plexor's movement is guided by a pair of opposite longitudinal slots defined on the wall of one of the telescopic members, each one of the slots retaining a lug formed on the plexor.

The plexor is resiliently biased by an impact spring toward the impact pad, said spring is partially or totally guided within the interior of the telescopic member that houses the plexor. The impact spring is supported at the other end by an end cap that is affixed to the open end of the telescopic assembly. This end cap is provided with hooks, which are received in corresponding lateral windows on opposite facing walls of the telescopic assembly. The cap is thus retained in this fixed position.

To produce a spark, a manual compressive force is applied to the telescopic assembly causing the inner and outer telescopic members to move toward each other. This action also compresses the return spring which separates the inner and outer members, and simultaneously compresses the impact spring to store energy therein. Towards the end of the contraction of the telescopic assembly, the plexor is released from the retaining mechanism and the compressed impact spring drives the plexor toward the impact pad, imparting the impact energy to generate an electrical potential or voltage across the piezoelectric element. Said potential is conducted through other conductive elements in the cigarette lighter, which make up an electrical circuit. This circuit has an open gap located near the valve where the fuel from a fuel supply is released. Said potential creates a spark across the gap and ignites the released fuel to create a flame. An example of such piezoelectric mechanism is disclosed in U.S. Pat. No. 5,262,697 entitled "Piezoelectric Mechanism For Gas Lighters". The disclosure of the '697 patent is hereby incorporated by reference.

It is desirable to increase the difficulty of using lighters to limit the ability of young children under five years of age to operate such piezoelectric lighters. For this reason, there have been attempts to provide "child-resistant" piezoelectric lighters offered in the patent literature. Examples of such patents include U.S. Pat. Nos. 5,145,358, 5,240,408, 4,904,180, 4,859,172, 4,786,248 and 5,228,849. Each of these disclosed devices has in common the fact that depression of the thumb pad, which compresses the telescopic assembly to activate the piezoelectric mechanism and release lever, is prevented from compression by a latch member which inhibits the production of sparks and release of fuel. Normally, the latch member is disposed between the thumb pad and a wall of the lighter body. This latch member must be aligned or positioned precisely between the thumb pad and the lighter body's wall in order to prevent the depression of the thumb pad.

Thus, there remains a need for a device, which limits the ability of young children to operate a piezoelectric ignition mechanism, and which would not require the use of a latch member.

SUMMARY OF THE INVENTION

Thus, it is an object of this invention to provide a lighter which limits the ability of unintended users to operate the lighter.

Another object of the invention is to provide a piezoelectric ignition mechanism which resists the production of sparks by unintended users, but does not require the use of a latch member.

Another object of the invention is to provide a piezoelectric lighter which requires a more forceful and purposeful depression of the thumb pad, which activates the piezoelectric mechanism.

These and other objectives can be achieved by a piezoelectric ignition mechanism comprising a telescopic assembly having an inner and outer members normally separated by a return spring, a piezoelectric element positioned inside the telescopic assembly, preferably inside the inner member, and a plexor movably disposed in the inner member. The plexor is resiliently biased toward the piezoelectric element by an impact spring, said impact spring is positioned between the plexor and an end member of the telescopic assembly. The plexor is normally positioned opposite the piezoelectric element, and is normally retained at a predetermined distance away from the piezoelectric element, such that when the plexor is released, it impacts against the piezoelectric element to produce a spark.

The ignition mechanism further comprises a resistant spring disposed within the telescopic assembly, such that it resists the continuing movement of the assembly to release the plexor. To produce a spark, the user compresses the telescopic assembly by depressing the inner member into the outer member. This action compresses the impact spring to store energy therein, and to release the plexor to allow the compressed impact spring to drive the plexor to impact against the piezoelectric element. However, prior to the release of the plexor, the user first at least partially compresses the resistant spring. The stiffness of the resistant spring can be selected to provide a desirable resistant force against the unwanted ignition of the piezoelectric mechanism by unintended users.

BRIEF DESCRIPTION OF THE DRAWINGS

To facilitate the understanding of the characteristics of the invention, the following drawings have been provided, wherein:

FIG. **1** is a front longitudinal view, in partial cross section, of the piezoelectric mechanism of the present invention in the rest or normal configuration, in an assembled position and located in a gas lighter assembly;

FIG. **2** is a front longitudinal view of the piezoelectric mechanism shown in FIG. **1**;

FIG. **3** is a partial cross-sectional view of the piezoelectric mechanism of FIG. **2**;

FIG. **4** is a front view of the inner telescopic member of the mechanism of FIG. **1**;

FIG. **5** is a front view of the outer telescopic member of FIG. **3**;

FIGS. **6** and **7** are front and side views of the plexor element;

FIGS. **8**, **9**, and **10** are respective front (shown partially in phantom), side and top views of an end cap for the outer telescopic member;

FIG. **11** is a front longitudinal view of the piezoelectric mechanism of FIG. **2** showing partial compression of the impact spring and no compression of the resistant spring;

FIG. **12** is a partial cross-sectional view of FIG. **11**;

FIG. **13** is a front longitudinal view of the piezoelectric mechanism of FIG. **2** showing full compression of the impact spring just before impact, and of the resistant spring; and

FIG. **14** is a partial cross-sectional view of FIG. **13**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, wherein like reference numbers are used to designate like parts, and as shown in FIG. **1**, piezoelectric ignition mechanism **10** of a lighter according to the present invention, shown in the rest or normal configuration, comprises first and second telescopic members, which include an outer telescopic member **12**, and inner telescopic member **14**. Return spring **16** is positioned between the outer assembly **12** and the inner assembly **14** to maintain a separation denoted by X between the two members. Piezoelectric mechanism **10** is disposed in a chamber **20** located in a body of a lighter, and is isolated from the fuel source, e.g., compressed hydrocarbon gas.

As also shown in FIGS. **2** and **3**, piezoelectric mechanism **10** comprises anvil member **22**, piezoelectric element **24** and impact pad **26**. Plexor member **28**, shown in phantom, in FIG. **3** and also in FIGS. **6** and **7**, is guided within inner telescopic member **14**. Plexor **28** is resiliently biased toward impact pad **26** by impact spring **30**, which is also disposed in inner member **14**. Outer member **12** also has end member **32** affixed thereon.

Plexor **28** has two lugs **34** formed on opposite sides thereof. Lugs **34** are received in longitudinal slots **36**, which are defined on opposite sides of inner member **14** as shown in FIG. **4**. Longitudinal slots **36** guide the displacement of plexor **28**, limiting it to the longitudinal direction. Each longitudinal slot **36** has retaining notch **38**. Lugs **34** are configured and dimensioned to protrude beyond slots **36** and into windows **40**, which are defined on opposite sides of outer member **12** as shown in FIGS. **1** and **5**. Window **40** also has an upper ramp surface **42** and lower ramp surface **44**. Thus, the displacement and movement of lugs **34** is controlled by slots **36**, notches **38** and ramp surfaces **42** and **44**.

In the normal or rest configuration shown in FIGS. **2** and **3**, lugs **34** of plexor member **28** are being held in notches **38** of longitudinal slots **36** on the inner assembly member **14**, and plexor **28** is retained at a predetermined distance X' away from impact pad **26**. Plexor member **28** is being resiliently pushed toward impact pad **26** by impact spring **30** as shown in FIGS. **2** and **3**. The bottom end of impact spring **30** abuts against ledge **46** of end member **32**. The bottom end of impact spring **30** is also received by boss **48** to assist in the positioning of impact spring **30**.

Also disposed within end member **32** and concentric with impact spring **30** is resistant spring **50**, which is positioned within channel **52** located on the bottom of end-member **32** as shown in FIG. **3** and more particularly in FIGS. **8** and **10**. Referring to FIGS. **8** and **9**, end member **32** also has hooks **54** disposed on opposite sides thereof. Hooks **54** engage with openings **58** on outer telescopic member **12** to retain end member **32** in outer member **12**. In the rest configuration depicted in FIG. **3**, resistant spring **50** is preferably not in physical contact with inner member **14**.

In order to generate a spark, a user normally depresses or pushes inner telescopic member **14** downward and into outer telescopic assembly **12** thereby compressing return spring **16** and impact spring **30**. As the inner telescopic assembly is being pushed downward, lugs **34** of plexor member **28** slide downward until it reaches the top of ramp surface **44**, as depicted in FIG. **11**. In a preferred embodiment, at or near this configuration, the bottom **60** (as depicted in FIGS. **3** and **12**) of inner telescopic member **14** comes into contact with resistant spring **50** (as shown in FIG. **12**).

Without the resistant spring **50**, the continuing depression of inner telescopic member **14** compresses impact spring **30** and pushes lugs **34** of plexor member **28** downward along ramp surface **44** until lugs **34** are released from notches **38** (for example, see FIG. **13**). After lugs **34** are released, plexor member **28** is immediately driven by compressed impact spring **30** toward impact pad **26** and strikes impact pad **26** to transfer the energy stored in impact spring **30** to piezoelectric element **24**, to thereby excite piezoelectric element **24** to create an electrical potential across same.

However, with the presence of resistant spring **50** when bottom **60** of inner telescopic member **14** comes into contact with resistant spring **50**, the amount of force required to continue to depress inner telescopic member **14** is suddenly increased. In other words, to continue to depress inner telescopic member **14**, the user must overcome the continuing resistance of impact spring **30**, as well as the additional resistance from resistant spring **50**. Resistant spring **50** is preferably dimensioned and configured so that the user has to at least partially depress spring **50** in order to release lugs **34** from notches **38**. Spring **50** can also be advantageously configured and dimensioned so that an adult user can overcome its resistant force while its resistant force may resist compression by a child user. If the user is able to at least partially compress resistant spring **50**, then lugs **34** can be moved from the top of ramp surface **44**, shown in FIG. **11**, to the bottom of ramp surface **44**, shown in FIGS. **13** and **14**, so that lugs **34** are released from notches **38** and are once again aligned within longitudinal slot **36**, and in the meantime impact spring **30** is being further compressed by the movement of lugs **34** along ramp surface **44**. Immediately after the release of lugs **34**, compressed impact spring **30**, with the aid of compressed resistant spring **50** drives plexor **28** toward the impact pad and strikes same.

After the impact pad **26** has been struck by plexor **28**, the user can simply release the thumb pad **62** (shown in FIG. **1**), thereby allowing the compressed return spring **16** to once again separate the inner and outer telescopic members from each other, until ramp surfaces **42** aligns with notches **38**. Due to the generally upward slope of ramp surface **42**, shown in FIG. **5**, lugs **34** of plexor **28** is pushed by impact spring **30** along ramp **42** until lugs **34** are deposited into notches **38**, such that lugs **34** and plexor **28** are retained in notches **38**. This is the rest or normal configuration depicted in FIGS. **1**, **2** and **3**.

Thus, the piezoelectric mechanism of the present invention presents a desirable high threshold level of force required for operation without requiring the use of a latch member.

Referring to FIG. **1**, after plexor **28** strikes impact pad **26**, which transfers the impact energy to the piezoelectric element **24**, an electrical potential difference is created across piezoelectric element **24**. Piezoelectric member **24** is one element in an electrical circuit comprising first electrode **64**, anvil **22**, piezoelectric member **24**, impact pad **26**, cam member **66**, valve actuator **68**, valve system **70** and second electrode **72**. Thus, the potential difference across piezoelectric element **24** is conducted through this circuit, and creates substantially the same potential difference between first electrode **64** and second electrode **72**. This potential difference is sufficient to discharge a spark across the air gap between the two electrodes. In other words, the two electrodes act similar to a capacitor with air dielectric disposed therebetween. Any electrically conductive material may be utilized to make the components of this circuit. A person of ordinary skill in the art may select suitable materials for the various components in this circuit.

When thumb pad **62** is depressed to create the spark, cam member **66** is also depressed, and acts on valve actuator **68**. Actuator **68** is pivoted such that when cam member **66** pushes one end of actuator downward, the other end is moved upward thereby lifting valve system **70** to release fuel gas. The released gas is then ignited by the spark discharged between electrodes **64** and **72**.

Valve system **70** controls the release of fuel from the fuel supply. In a preferred embodiment as shown generally in FIG. **1**, the fuel supply is compressed hydrocarbon gas and valve system **70** is a normally open valve, forced closed by the pressure of a spring member **74**. In this embodiment, valve actuator **68** acts on valve system **70** to lift valve stem **76** upward to release the compressed hydrocarbon gas.

In another embodiment, a normally closed valve, forced closed by an internal spring can be used with a valve actuator which exerts an upward pressure on valve system **70** to open the valve.

To operate the lighter, the user first depresses thumb pad **62**, which causes cam member **66** to engage valve actuator **68** to lift valve stem **76** to release fuel gas. The depression of thumb pad **62** compresses impact spring **30** until inner member comes into contact with the top of resistant spring **50**. At or near this point, the user should exert additional force to overcome spring **50** in order to cause plexor **28** to be released from the retaining mechanism thereby allowing compressed spring **30** to drive plexor **28** against impact pad **26** and causing piezoelectric element **24** to produce a spark to ignite the released fuel to produce a flame. To extinguish the flame, the user simply releases thumb pad **62** thereby releasing valve actuator **68** allowing spring **74** to close valve system **70**. Spring **16** returns the piezoelectric ignition mechanism **10** to its rest or normal configuration as shown in FIGS. **1**, **2** and **3**. The piezoelectric ignition mechanism of the present invention may also used with a natural gas oven range, an outdoor gas grill or similar devices to increase the degree of difficulty for operation and therefore its level of resistant to undesirable operation by children.

While it is apparent that the invention herein disclosed is well calculated to fulfill the objects above stated, it will be appreciated that numerous modifications and embodiments may be devised by those skilled in the art, and it is intended that the appended claims cover all such modifications and embodiments as fall within the true spirit and scope of the present invention.

What is claimed is:

1. A piezoelectric ignition mechanism comprising:

a telescopic assembly having first and second members;

a return spring associated with the first and second members for biasing the first and second members away from each other;

a piezoelectric element positioned inside the telescopic assembly;

a plexor movably disposed in the telescopic assembly and is resiliently biased by an impact spring, said impact spring is supported at the other end by an end member of the telescopic assembly, said plexor is retained at a predetermined distance away from the piezoelectric element, such that when the plexor is released, it impacts against the piezoelectric element to produce a spark;

wherein the ignition mechanism further comprises a resistant spring disposed within the telescopic assembly, such that it resists the release of the plexor.

2. The piezoelectric ignition mechanism according to claim **1** wherein the piezoelectric element is disposed in the first member of the telescopic assembly, and wherein the plexor comprises at least one lug disposed on its side, said at least one lug is received by at least one longitudinal slot defined on the first member, so that the movement of the plexor is guided by said at least one longitudinal slot.

3. The piezoelectric ignition mechanism according to claim **2** wherein the first member further defines at least one notch connected to said at least one longitudinal slot, such that when the at least one lug is received in the at least one notch, the plexor is positioned at said predetermined distance from the piezoelectric element.

4. The piezoelectric ignition mechanism according to claim **3** wherein the second member defines at least one release ramp, so that when the first member is moved toward the second member, the at least one lug rides on the release ramp until the plexor is released from the at least one notch.

5. The piezoelectric ignition mechanism according to claim **4** wherein the resistant spring resists the release of the plexor from the at least one notch by resisting the movement of the first member toward the second member.

6. The piezoelectric ignition mechanism according to claim **5** wherein the resistant spring is disposed in the end member of the telescopic assembly.

7. The piezoelectric ignition mechanism according to claim **6** wherein a bottom of the first member comes into contact with the resistant spring and at least partially compresses same, before the plexor is released to impact the piezoelectric member.

8. The piezoelectric ignition mechanism according to claim **7** wherein an impact pad is positioned between the piezoelectric member and the plexor.

9. The piezoelectric ignition mechanism according to claim **5** wherein the end member defines a channel to receive the resistant spring.

10. The piezoelectric ignition mechanism according to claim **5** wherein an applied force, required to move the first member toward the second member and to release the plexor to impact an impact pad disposed between the plexor and the piezoelectric element to produce a spark, is increased during said movement to at least partially compress the resistant spring in order to release the plexor.

11. A piezoelectric ignition mechanism comprising:

a telescopic assembly having first and second members;

a return spring associated with the first and second members for biasing the first and second members away from each other;

a piezoelectric element positioned inside the telescopic assembly;

a plexor movably disposed in the telescopic assembly and is resiliently supported by an impact spring, said impact spring is supported at the other end by an end member of the telescopic assembly;

means for retaining the plexor at a predetermined distance away from the piezoelectric element and means for releasing the plexor such that after the plexor is released, it impacts against the piezoelectric element to produce a spark; and

a resistant spring disposed within the telescopic assembly, such that it resists the release of the plexor.

12. The piezoelectric ignition mechanism according to claim **11** wherein the resistant spring is disposed in the end member of the telescopic assembly.

13. The piezoelectric ignition mechanism according to claim **12** wherein a bottom of the first member comes into contact with the resistant spring and at least partially compresses same, before the plexor is released to impact the piezoelectric member.

14. The piezoelectric ignition mechanism according to claim **13** wherein an impact pad is positioned between the piezoelectric member and the plexor.

15. The piezoelectric ignition mechanism according to claim **13** wherein the end member defines a channel to receive the resistant spring.

16. The piezoelectric ignition mechanism according to claim **13** wherein an applied force, required to move the first member toward the second member and to release the plexor to impact the piezoelectric element to produce a spark, is increased during said movement to at least partially compress the resistant spring in order to release the plexor.

17. A lighter comprising:

a lighter body containing a fuel reservoir having a valve for releasing fuel therefrom;

a valve actuator depressible to actuate said valve to release said fuel; and

a piezoelectric ignition mechanism which comprises a telescopic assembly having first and second members normally separated by a return spring, a piezoelectric element positioned inside the telescopic assembly, a plexor movably disposed in the telescopic assembly and is resiliently supported by an impact spring, said impact spring is supported at the other end by an end member of the telescopic assembly;

said a piezoelectric ignition mechanism further comprises means for retaining the plexor at a predetermined distance away from the piezoelectric element, means for releasing the plexor such that after the plexor is released, it impacts against the piezoelectric element to produce a spark, and a resistant spring disposed within the telescopic assembly, such that it resists the release of the plexor.

18. The lighter according to claim **17** wherein a bottom of the first member of the piezoelectric ignition mechanism comes into contact with the resistant spring and at least partially compresses same, before the plexor is released to impact the piezoelectric member.

19. The lighter according to claim **18** wherein an applied force, required to move the first member toward the second member and to release the plexor to impact the piezoelectric element to produce a spark, is increased at a first rate during said movement before the first member contacts the resistant spring and at a second rate once the first member at least partially compresses the resistant spring.

20. The lighter according to claim **19** further comprises an anvil member and two electrodes, said electrodes define a gap therebetween such that the spark generated by the impact between the plexor and the piezoelectric element is conducted to the electrodes and discharged from one electrode to the other to ignite the released fuel.

21. The piezoelectric ignition mechanism according to claim **1**, wherein the resistant spring is associated with the telescopic assembly such that the resistant spring is compressed by the first and second members after the first and second members have been moved towards each other by a distance that is insufficient to release the plexor.

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